Spatial knowledge dynamics from a firm perspective: The use of innovation biography to grasp time and space in energy technology development

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1 Introduction

Firms innovate, in part, by combining existing and new knowledge (Kogut, Zander 1992). Because only few firms are able to generate all the knowledge it requires internally, firms involved in innovation processes consequently often search for external knowledge in order to develop and deploy new ideas in their product portfolio. It is increasingly acknowledged that firms' ability to acquire external knowledge is constrained by the firm's own experiences and competences (Nelson, Winter 1982) including its geographical and technological distances to the source of knowledge (Antonelli 2001, Jaffe, Trajtenberg et al. 1993).

However, there are numerous examples from the literature showing how firms are able to overcome its geographical boundedness and gain access to extra-local knowledge that can be integrated in the firm's innovation process. To capture this, Bathelt et al. (2004) have developed the concepts of 'local buzz and global pipelines' to comprise this dyadic relationship between local and global knowledge flows. Local buzz complements formalized local learning processes that take place either within the boundaries of an organisation or between organisations, for example, in research projects or in user-supplier relationships.

> "*This buzz consists of specific information and continuous updates of this information, intended and unanticipated learning processes in organized and accidental meetings, […] which stimulate the establishment of conventions and other institutional arrangements.*" (Bathelt, Malmberg et al. 2004, p. 38)

Global pipelines are on the other hand channels of communications to knowledge providers located outside the regional economy, which outward looking firms have invested in. Bathelt et al. argue that the co-existence of high levels of buzz and many pipelines in a regional economy creates advantages that are not available to outsiders, thus, increasing the innovative output. Consequently, there is a great interest in understanding the fundamental dynamics of the dyadic relationship between local and global knowledge search. Different types of 'global pipelines' or concrete ways whereby firms overcome geographical and technological constraints, include mobility of inventors and other skilled personnel, the formation of strategic alliances (Rosenkopf, Almeida 2003), patent acquisition, and purchase of technology or products with embedded knowledge.

The literature on 'local buzz and global pipelines' has given rise to at least two streams of empirical studies. One stream has focused on cluster-dynamics and has conducted mainly meso-level analysis (see e.g.,Isaksen 2003) . Another stream of studies has had a micro-level starting point and has paid

more attention to the role of the firm. The firm-based studies have either focused on the degree to which firms collaborate internationally (Gertler, Levitte 2005, Murtha, Lenway et al. 2001); the *types* of global pipelines (such as inventor mobility and alliances, Rosenkopf, Almeida 2003), or on identifying the type of actors that function as global pipelines (Benneworth, Hospers 2007). What is still lacking, however, is a more thorough understanding of the innovation process that takes place in the firm and which lead to extra-regional knowledge integration.

Hence, the objective of this study is to examine firms' internal procedure for innovation activities with a particular focus on how firms integrate external knowledge. This study is guided by a set of provisional research questions: a) under which circumstances do firms search for external knowledge? b) Which factors influence the spatial scale of a firm's knowledge search? c) How do firms approach external knowledge sources?

To answer these questions I apply a relatively lately developed methodology building on a biographical approach (Strambach 2012). The biographical method is characterized in that it focuses on the innovation event itself: the actors involved; the relationships between them; their knowledge contribution; and their geographical and institutional settings (Strambach 2012, pp. 61-63). The biographical method includes, in addition to the geographical dimension, a strong emphasis on the time dimension since it focuses on the entire "lifespan" of the innovation activities from idea generation to production of the new product. The method thus involves interviewing other firms and types of actors who have been involved in the innovation activities managed by the core firm.

A secondary objective of this study is, thus, to assess the usefulness of applying an innovation biography method to the examination of spatial knowledge dynamics.

It is anticipated that the results will give insights on the barriers and incentives in small and medium-sized enterprises for integrating knowledge from multiple spatial scales. This sort of insight can be important for formulating supportive policies that can promote firms to search globally for knowledge.

2 The wind power industry of Denmark

Few years ago the majority of the world's production capacity of wind turbines was located in Northern Europe, with its center of gravity in Denmark. However, in 2010 the production units in Europe supplied approximately 41 % of the world's installed wind power capacity (measured in MW) while production units in China and India delivered close to 48 %. This development is a result of a rapidly changing globalization process, which the wind power industry experiences in these years. One of the major reasons for this trend is changes in the development of the wind power markets

Until a decade ago the wind power industry was dominated by a handful of Danish wind turbine manufacturers. Since then the Danish wind turbine manufacturers have undergone a process of consolidation and today only Vestas is considered Danish.[1] And in parallel with this development the

[1] Siemens Wind Power has until recently also been considered Danish, since the company is based on the former Danish company Bonus Energy. However, in 2011 Siemens Wind Power moved the headquarter to

international competition has increased as is seen on Figure 1 showing the largest wind turbine manufactures in 2010. Consequently, Denmark is no longer the undisputed geographical center for wind power. Today, many other regions in Europe and across the world employ significant shares of the total wind power employment.

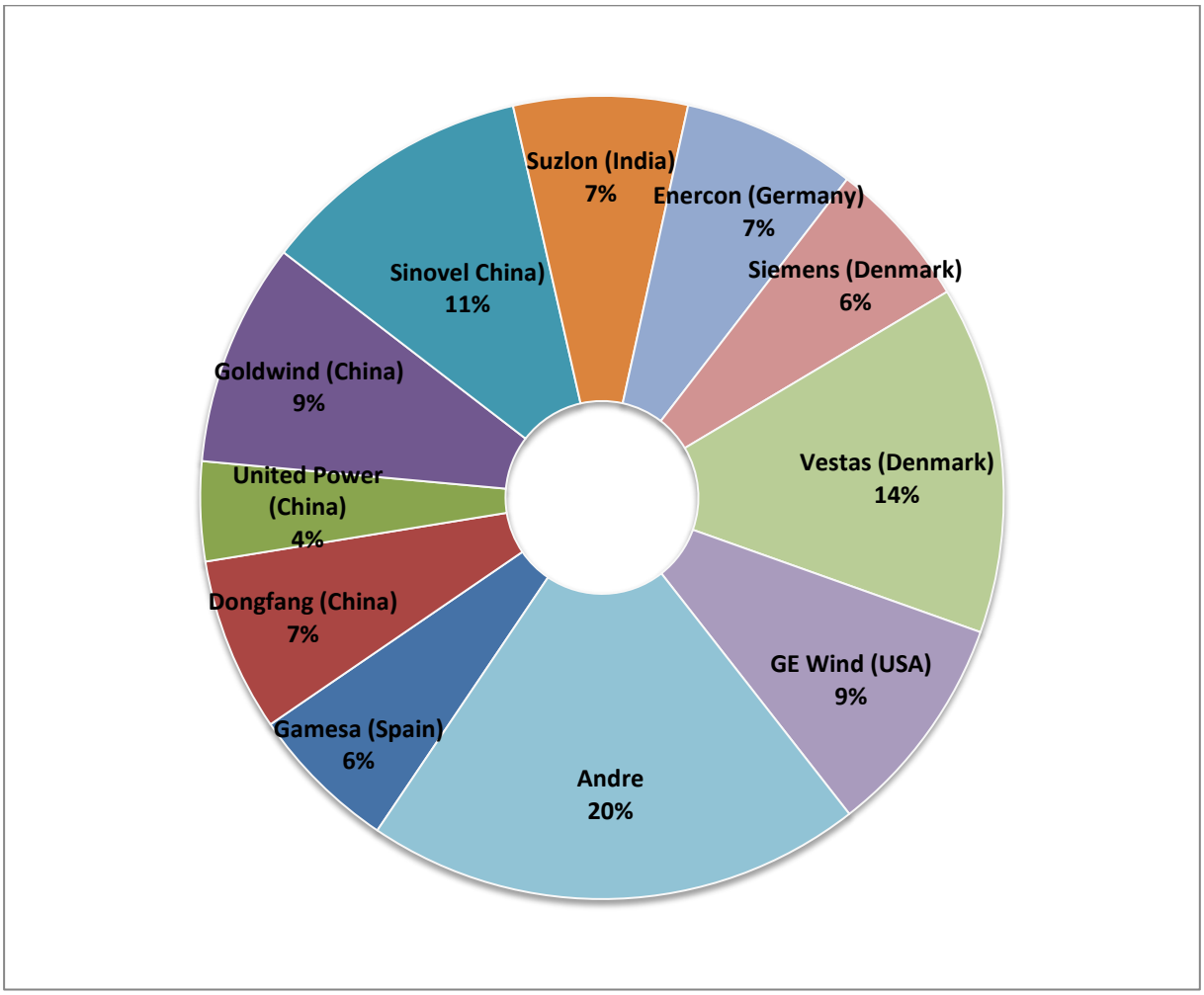

Figure 1: The largest producers of wind turbines in 2010 based on marked shares (Source: Vindmølleindustrien 2012)

This development has partly been driven by the spatial distribution of the demand for installed MW wind power, since there is a tendency that the creation of local production units follows the spatial distribution of installed MW (Vindmølleindustrien 2012). The reasons behind this are public provisions about the shares of locally manufactured components in locally installed wind turbines.

Nevertheless, Denmark is still an important player in the wind power industry. In 2011 the global turnover increased to 102.8 bn. and half of the global turnover was placed in Denmark (approx. 52 bn.). The employment in the wind power industry in Denmark has been stable in the years 2009-2011 around approximately 25,000 persons. Seen over a 5 year period from 2006 to 2011 wind power related export from Denmark has increased by 8 % per year. And although the export

Hamburg as a result of a reorganization of Siemens. Siemens Wind Power still has production sites and R&D facilities in Denmark.

decreased by 16.1 % from 2010 to 2011 the export from the wind power sub-suppliers increased from 2010 to 2011. These figures illustrate a situation that is characterized by Vestas' downturn but at the same time an increasing export from sub-suppliers who has succeeded in going global and reached other markets.

The globalization is driven by large manufacturers that act internationally and which have led Danish sub-suppliers to adjust to the new situation. In most cases the sub-suppliers have followed the manufacturers to the 'new' markets and have succeeded in becoming sub-suppliers for 'local' manufacturers, for example in China.

Because of the strong anchoring of the wind power industry we would expect a lot of knowledge dynamics to be anchored here and less knowledge to *flow* beyond the national borders. However – the international competitive challenges that the industry experience today have made scholars recommend the industry to start looking beyond national borders in integrating new knowledge.

3 Methodological approach

To advance our understanding of the nature of knowledge dynamics in the wind turbine industry in Denmark the analysis builds on an inductive methodology following a grounded theory approach (Glaser, Strauss 1967). To achieve an appropriate balance between interpretation and data, it has been useful to begin the data gathering process concurrently with a continuous process of investigating the nature of the research question, developing a plan, refining the method used to gather data, and initiating a data dependent coding of the gathered data (Heath, Cowley 2004). Most importantly, it has been key to decide on the data gathering method at a very early stage in order to begin this process.

This study makes use of a biographical approach focusing on the innovation process in the wind turbine industry. Consequently, it is not a firm's intended procedure in general that is the focus of this study but the process of product development activities that takes place within and beyond the borders of the firm. Through interviews with people who have been involved in the innovation process it is the purpose to uncover a) the actors involved b) the relationships between them c) their knowledge contribution and d) their geographical and institutional settings (Strambach 2012, pp. 61-63). The advantage of the innovation biography approach is that it gives concrete insight into tangible procedures of new product development without using the methods of observations. The method of innovation biographies also overcome the issues related to another type of qualitative studies where managing directors or head of R&D divisions are interviewed alone about general aspects of a phenomenon, for instance distributed innovation processes. In such cases the researcher is often presented for *the ideal situation* for the company or for a lot of post-rationalization.

There are several reasons why such a relatively novel approach is considered worth to apply in studies of innovation activities, and why such an approach may differ from previously applied methods in the field of economic geography and innovation studies in general. First, the methodological approach of innovation biographies has been argued to be, in an economic geography perspective, very advantageous because the biographical method can focus on the distributed knowledge generation activities and their evolvement over time, and this, without being

limited by a certain territorial scope. As Strambach (2012, p.62) puts it: "Knowledge interactions can be mapped regardless of geographical or sectoral scale". Thus, the starting point of an analysis building on a biographical approach distinguishes itself from other economic geography studies in that it does not have a very rigid focus on knowledge dynamics within and beyond one particular region, for example cluster studies. Instead it applies a more flexible territorial understanding.

Second, although there are similarities to the historical technology studies by for example Hughes (1983) or Bijker (1997), there appears to be one major difference, and that is, the level of analysis. Hughes and Bijker focuses on technological development at a system level, technological or socio-technical system, respectively which has led to interesting findings at the level of technological development at a system level. For example Hughes' concept of reverse salient, which refers to a situation where one component of the system, that due to its insufficient development, hinders the whole system from performing in an optimal way (Hughes 1983). It is not the ambition with this study to create findings of such character, i.e. at the level of technological systems.

Instead, in the method of innovation biography, focus is on the innovation process at the micro level and how this process is linked or embedded in a macro context of the larger technological innovation system. And here it is important to emphasize that it is the technological **innovation** system that is considered, since both technological conditions for innovating and conditions for the diffusion of this new innovation matters in framing the conditions for the innovation.

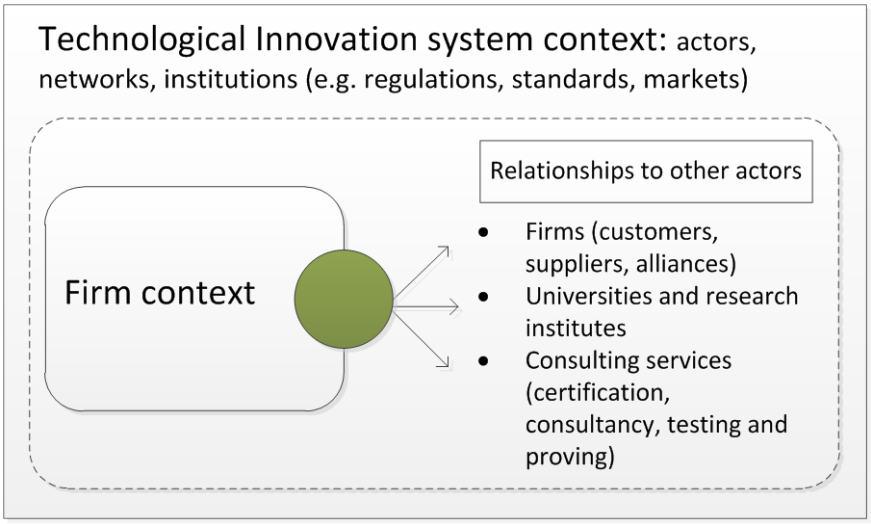

Figure 2: The analytical object of the study is the innovation process illustrated as a green circle. This process is embedded in a firm context as well as an innovation system context

Figure 1 illustrates the focal point of the analysis – the innovation process of a new product. The figure furthermore illustrates how this process is embedded in a firm context (organizationally and institutionally) and in a broader technological innovation system context which is configured by actors, networks, and institutions and the relationship between these elements.

The data collection process is balanced between the narrative of the project owner and a focus on the firm's context and its linkages to other partners in the process of innovation. First, the narrative part of the interviews is constructed to enable the interviewee to provide an uninterrupted narrative of the innovation project that is in focus. A second part of the interview is structured over a number

of questions about the relationships to other actors in the innovation process. A third part of the interview is guided by a number of questions about the firm's internal organization and established procedures for developing new products, and about other actions the firm may use to integrate external knowledge into the firm (e.g. hiring skilled staff, licensing patents, creating strategic alliances).

Further points to be added later versions

- The biographical method includes, in addition to the geographical dimension, a strong emphasis on the time dimension since it focuses on the entire "lifespan" of the innovation event. The method thus involves interviewing participating actors inside and outside the firm that hosts the innovation event.
- Innovation biography differs from previous applied methods in the field of economic geography or innovation studies in general:
- The focus is on the innovation event itself the actors involved, their relationship, their knowledge contribution and their geographical and institutional settings.
- The method origins from sociology where it has increased its usage and its legitimacy over the past couple of decades (Chamberlayne, Bornat et al. 2000).

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